An Evaluation of the Displaying Method on the Braille Learning System for the Sighted: For Understanding of the Mirror Image Relation

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Abstract. The present work evaluates the effectiveness of adding blank cells to the 3DCG display of braille characters in the braille learning system for sighted learners to understand the mirror image relation between the written and read characters. The results of tests indicate the effect of the addition of blank cells to the 3DCG display in advancing the understanding of the mirror image relation.

Keywords: Braille · Displaying method · Blank cells · Mirror image relation Sighted

1 Introduction

Braille, a set of characters consisting of raised dots arranged in cells, enables visually impaired to communicate with others. The system was invented by Louis Braille, a French educator who was blind himself.

The braille system for the Japanese language was developed by Kuraji Ishikawa, a teacher at Tokyo Blind and Dumb School. A character of Japanese braille consists of six dots in a cell, of which three represent a consonant, and the three others a vowel, of a syllable of the language. A character of Japanese braille thus corresponds to a syllabic character of Japanese.

A braille text is read from left to right by touching the raised dots in left-aligned lines. Braille characters must therefore be written from right to left as right-aligned lines of recessed dots. The configuration of the recessed dots formed on the backside of the paper is thus a mirror image of raised dots on the front side. This circumstance is referred to as the "mirror image relation" hereinafter.

Several systems have been developed to support sighted learners of braille. Putnam and Tiger [1] wrote a program for learning English braille. Evaluation by four sighted students proved that the program enabled all the learners to understand the relationship of braille characters and corresponding printed letters.

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Motoki [2] developed and evaluated a Web-based system to support sighted braille learners. The system intended to familiarize learners with the basic rules of Japanese braille as well as the mirror image relation by providing three-dimensional computer graphic (3DCG) images of braille characters. Tests in which the learner filled circles corresponding to points to be indented when writing braille characters revealed two types of errors indicating lack of understanding of the mirror image relation: Error 1 in which each character is singly inverted in the order in the original string, and Error 2 in which the entire string is correctly inverted but left-aligned. He suggested that such errors were caused by inadequate specifications of the 3DCG. It provided the same number of cells to fill with braille characters as needed for an actual text, which meant that no hint was given as to right- and left-alignment of characters. Since this may have impeded clear understanding of the mirror image relation on the learner's part, he pointed out the necessity of an improved 3DCG system.

Hoshino and Motoki [3] proposed an improved 3DCG display design including additional blank (entirely flat) cells after the braille cells proper, and determined experimentally the number of the blank cells to be added for braille strings consisting of 1–10 characters. However, effects of this measure on learning have not been evaluated.

The purpose of the present work is to evaluate the effectiveness of the 3DCG braille display with added blank cells proposed by Hoshino and Motoki [3] for supporting sighted learner's understanding of the mirror image relation. Two 3DCG systems were made available for the test participants.

2 Participants and Setting

Tests were performed with 39 undergraduate students studying library service for the handicapped. All the participants were sighted native speakers of Japanese.

Tests utilized two types of braille learning systems including different 3DCG systems: System N without a blank cell and System A with added blank cells. Figure 1 shows examples of braille characters displayed in each system.

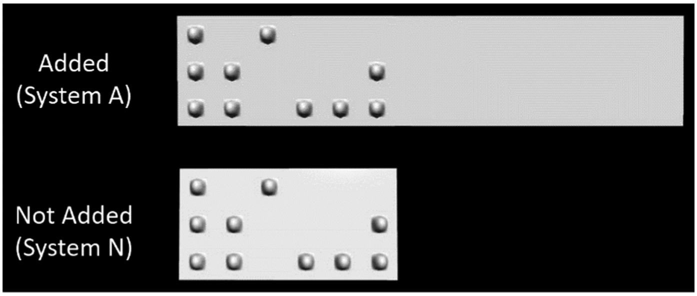

Fig. 1. Examples of braille characters displayed in the two 3DCG systems

The participants were divided into a control group and an experimental group. The control group, consisting of 17 students, used System N, while the experimental group of 22 students used System A.

A test concerning braille was performed on the control group on May 27, 2016 without prior notice to know the knowledge level of the group. The group was then permitted to use System N and asked to practice braille writing in arbitrary schedules. A similar test was performed on July 22, or eight weeks after the release of the system, without prior notice.

Likewise, a test was performed on the experimental group on June 2, 2017 without prior notice. The group was permitted to use System A on June 16, or two weeks after the test, and asked to practice braille writing. A similar test was performed On July 21, or five weeks after the release of the system, without prior notice.

All the test consisted of questions of an equivalent level. The full score was set to 15 points. The average and standard deviation of the scores in each test were calculated. In addition, the proportion of students who gave Errors 1 and 2 was calculated to evaluate the effectiveness of studies on the mirror image relation.

3 Results

The tests before the system release yielded average scores of 2.12 (S.D. = 4.21) for the control group and 0.82 (S.D. = 2.92) for the experimental group. The scores in the tests after the system release rose to 5.65 (S.D. = 4.3) and 7.45 (S.D. = 5.26), respectively.

The participants in each group were divided into subgroups according to the difference between the scores in the two tests, and the population percentages of individual subgroups within each group were calculated. The two groups were compared in terms of the population percentages in individual subgroups (Fig. 2).

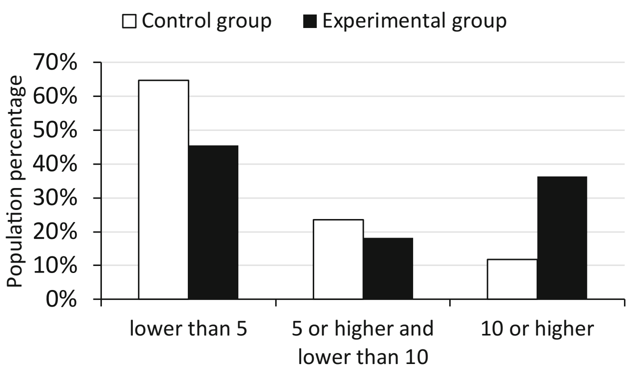

Fig. 2. Relative population in subgroups within the two groups

Figure 2 indicates that, for the experimental group, the population percentage of the subgroup with score difference of 10 or higher is greater than that with score difference of 5 or higher and lower than 10, while the population percentage decreases monotonously with increasing score difference in the control group. This tendency can be attributed to the introduction of blank cells in the 3DCG display used by the experimental group in the tests.

The control group yielded Error 1 answers by 24% of the members and Error 2 by 6%. The experimental group gave no Error 1 but Error 2 answers by 5%. A significant difference between the control and experimental group was observed for Error 1 only, which suggests effectiveness of the 3DCG with additional blank cells in improving learner's understanding of the need of reversing the entire string when producing a braille text.

4 Conclusion

The present work evaluates the effectiveness of adding blank cells to the 3DCG display of braille characters in supporting learners to understand the mirror image relation between the written and read characters.

Two groups of subjects were asked to practice braille, each using a braille learning system including a different 3DCG systems. Tests on braille were performed before and after the practice to assess the learning effect. The group that used the 3DCG system with added blank cells showed a higher proportion of participants who improved the scores by 10 points or more in the second test. A characteristic error found in a previous study in which braille characters were singly inverted in the order in the original string instead of inverting the entire string did not appear in the group using the 3DCG system with added blank cells.

These results indicate the effect of the addition of blank cells to the 3DCG display in advancing the understanding of braille. Particularly the addition of blank cells provided learners with a clear indication that the entire string must be inverted when writing a braille text.

While the present study concerns Japanese braille only, character display with additional blank cells will be useful in learning braille for other languages. Similar studies on non-Japanese braille systems are desirable.

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